

Real-time Suomi-NPP Green Vegetation Fraction for Improving Numerical Weather Prediction and Situational Awareness

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Introduction

- NASA SPoRT has incorporated Suomi-NPP products into its research and transition activities to improve regional land surface models (LSMs) and numerical weather prediction (NWP)
- Daily global VIIRS green vegetation fraction (GVF) are used to improve the representation of vegetation in the Noah LSM over existing climatological GVF to better simulate:
 - Land-atmosphere energy exchanges during anomalous weather/climate regimes
 - Temperature, moisture, and precipitation features, esp. during warm season

Background on GVF for Regional Modeling

- NESDIS VIIRS daily global GVF product (Vargas et al. 2013; annual AMS meeting)
- 4-km resolution based on the VIIRS Enhanced Vegetation Index
- Over three years of daily data available from NOAA/NESDIS [1 Sep 2012 to present]
- Conversion routines developed to ingest VIIRS GVF into Land Information System (LIS) and Weather Research and Forecasting (WRF) modeling systems
- SPoRT MODIS-based real-time GVF for land surface modeling and regional NWP
 - Continental U.S. (CONUS) domain at 0.01-deg resolution since 1 June 2010, updated daily with NDVI Direct Broadcast swaths from University of Wisconsin
 - Case et al. (2014; IEEE TGRS) documented model sensitivity and impacts
- Both NESDIS/VIIRS and SPoRT/MODIS GVF publicly available for use in WRF model
- Analysis compares the daily VIIRS GVF to the existing monthly MODIS/FPAR GVF climatology available to the WRF modeling community (NCAR/Barlage MODIS dataset; derived from 2001-2010 MODIS data)

Methodology and Tools

- Three-year offline simulations of Noah LSM in LIS framework
 - Extension of long-term soil moisture climatology run (1981-2012)
 - Ran with monthly MODIS GVF climatology (control run)
 - Replaced GVF climatology with daily global 4-km NESDIS/VIIRS GVF
 - Analyzed sensitivity with Land surface Verification Toolkit (LVT)
- WRF model simulations during May 2013
 - Picked this month to examine possible impacts due to late greenup, esp. in Midwest
 - Daily WRF model 48-h simulations driven by NAM model initial and boundary conditions
 - Control: MODIS GVF climatology
 - Experimental: daily NESDIS/VIIRS GVF product

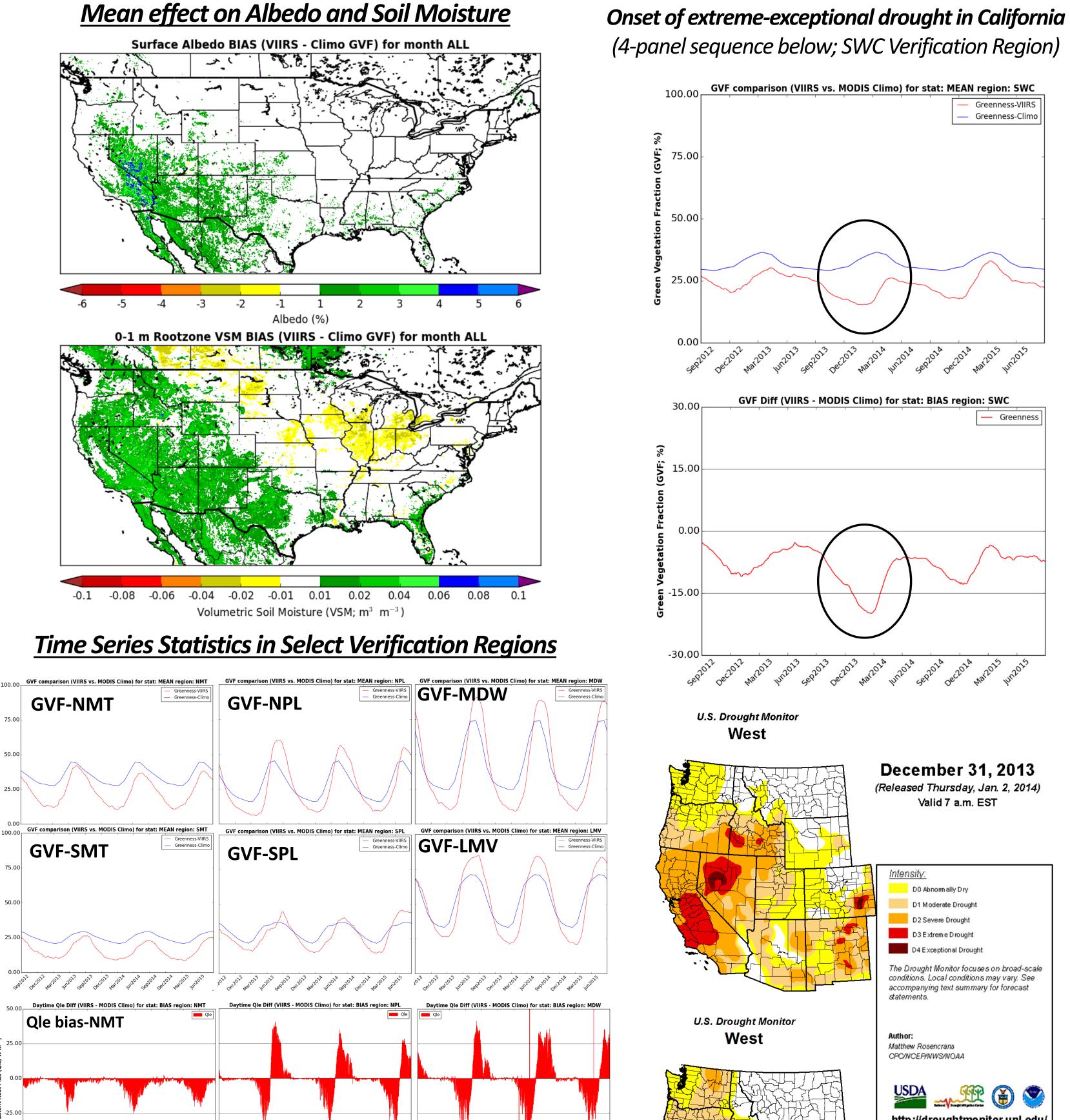
Summary and Future Plans

- Daily NESDIS/VIIRS GVF incorporated into real-time LIS run at SPoRT
 - Offline Noah LSM on full CONUS domain at 0.03-deg resolution
 - SPoRT-LIS output and VIIRS GVF disseminated to select NWS partners for enhanced situational awareness within AWIPS II
- Summary of VIIRS vs. MODIS GVF Climatology over Continental U.S.
 - VIIRS has greater annual dynamic range, but overall lower bias
 - VIIRS depicts GVF anomalies related to drought and abnormal temperatures
 - Corresponding differences occur in mean heat fluxes and soil moisture due to evapotranspiration changes
 - WRF model responds with higher (lower) daytime 2-m T (Td) in clear skies; higher CAPE in Southern Plains where VIIRS GVF is higher over wheat fields
- Future Plans
 - VIIRS GVF-enhanced LIS for international applications in Central America, Caribbean, eastern Africa, and/or south-central Asia

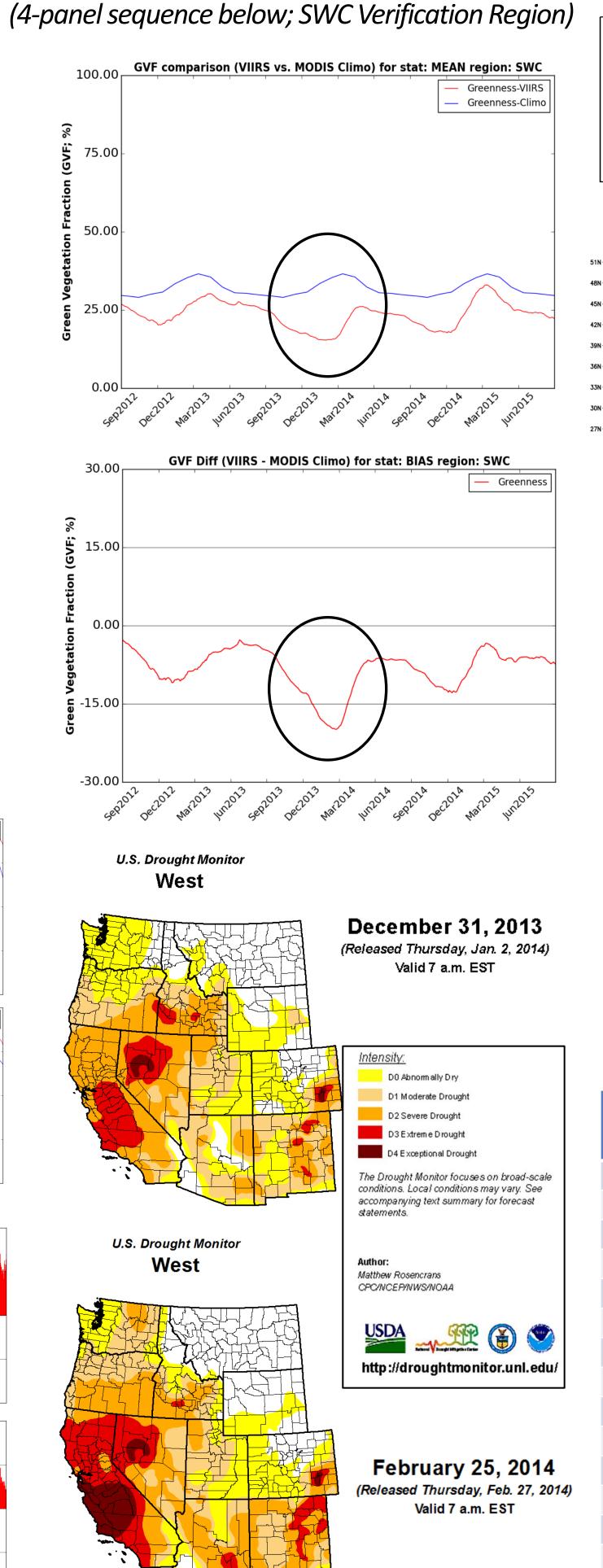
GVF and LIS/Noah LSM Analysis with Land surface Verification Toolkit (2012-2015)

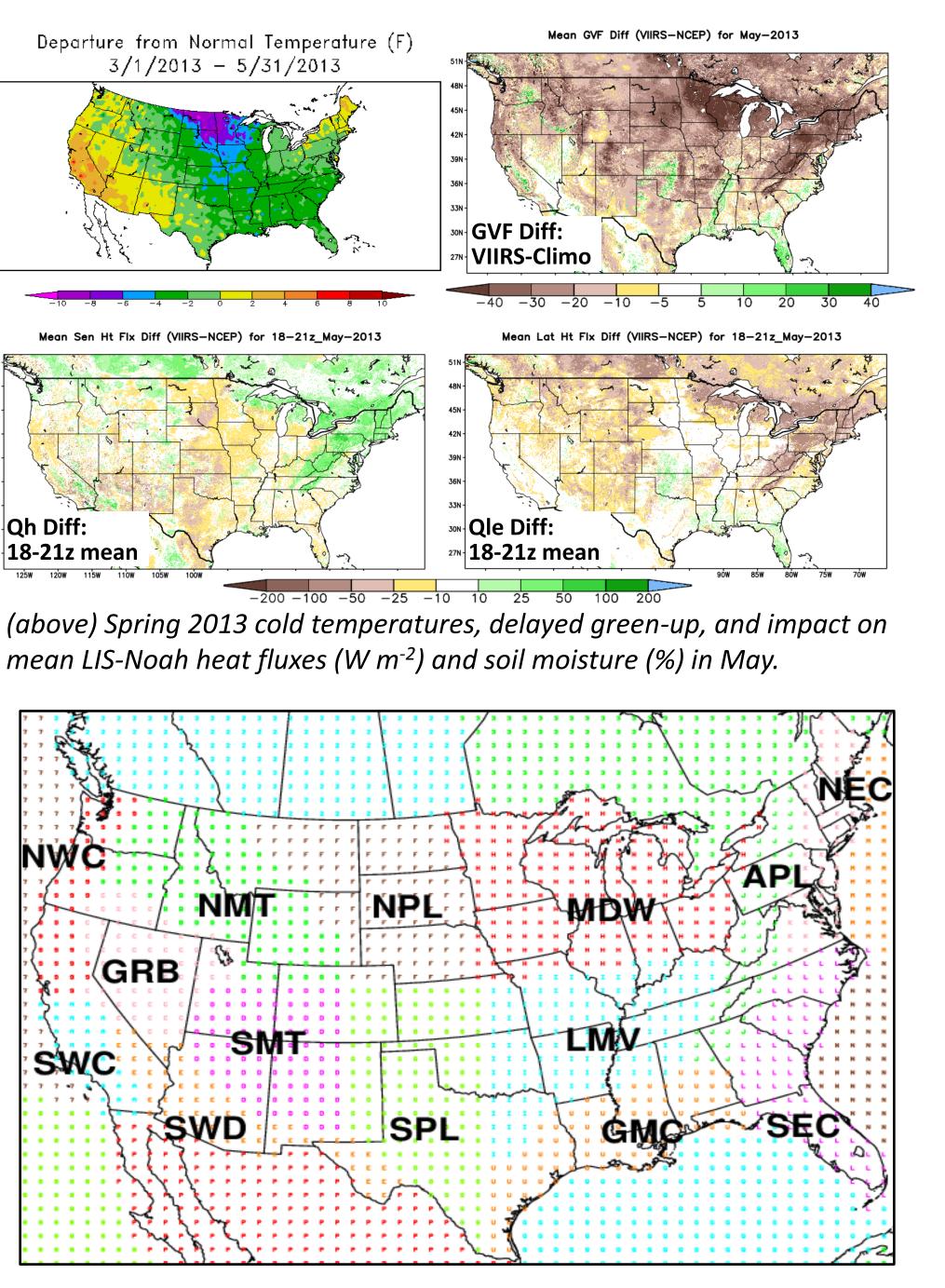
Overall GVF 3-year Statistics Green Vegetation Fraction RMSE (VIIRS - Climo GVF) for month ALL

-0.9 -0.75 -0.6 -0.4 -0.2 0.2 0.4 0.6 0.75 0.9



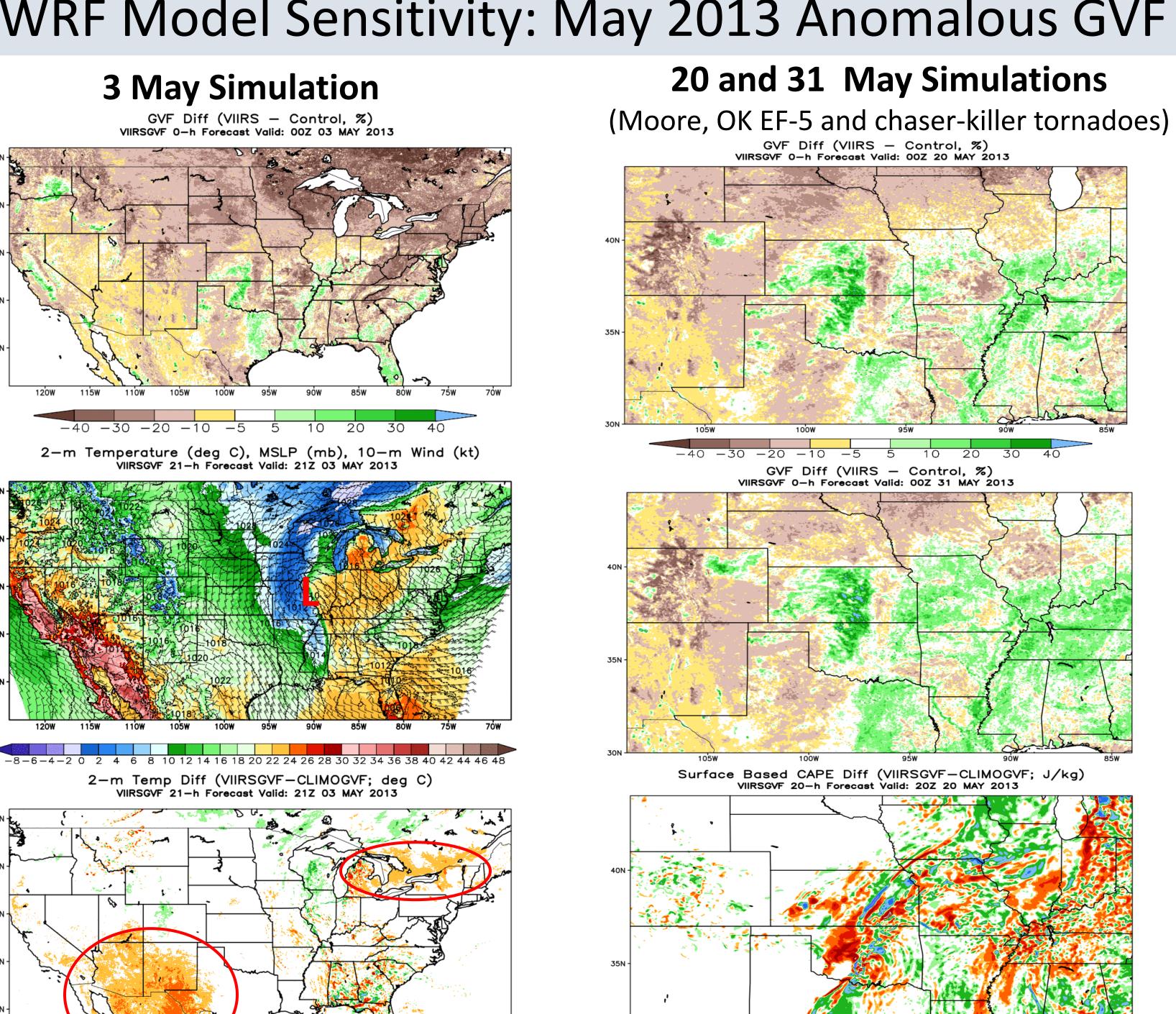
Qle bias-SMT

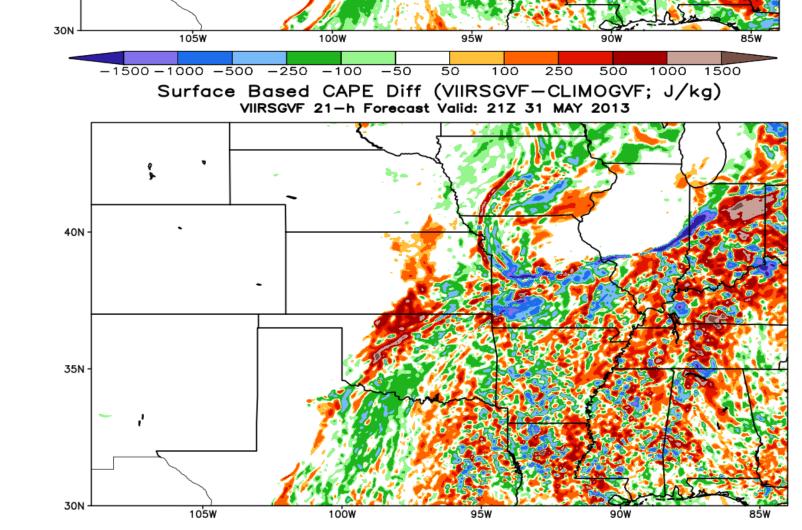




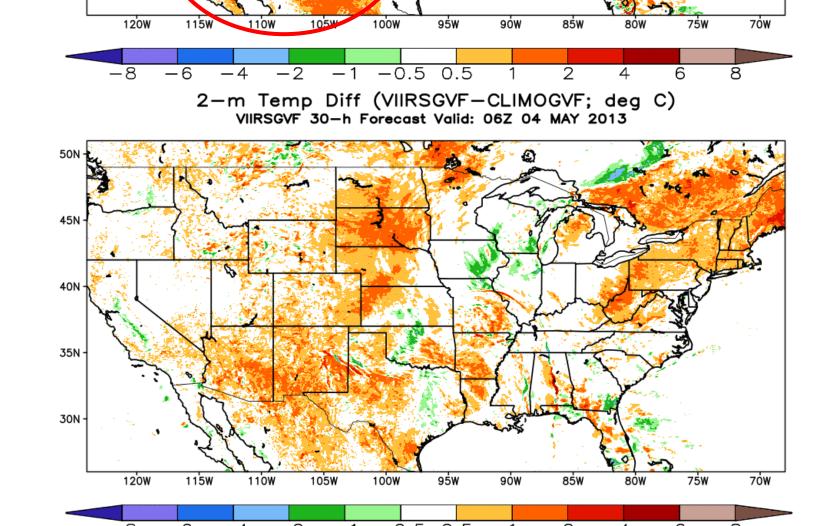
NCEP Verification	Greater GVF dynamic range	VIIRS GVF Bias
Region (W to E)	(MODIS, VIIRS, or Same)	(High, Low, or None)
NWC	VIIRS	Low
SWC	VIIRS	Low
GRB	Same	Low
SWD	Same	Low
NMT	VIIRS	Low
SMT	VIIRS	Low
NPL	VIIRS	None
SPL	VIIRS	None
MDW	VIIRS	None
LMV	VIIRS	None
GMC	VIIRS	Low
APL	VIIRS	Low
NEC	VIIRS	Low
SEC	VIIRS	Low

WRF Model Sensitivity: May 2013 Anomalous GVF





Similar WRF model response associated with GVF diffs: → higher GVF & CAPE, northern & western OK → lower GVF & CAPE, central TX to southern OK → Little difference in forecast precip (not shown)



Expected result: Warmer 2-m T during day in clear areas (3rd panel); <u>Unexpected</u>: Warmer nighttime 2-m T (bottom panel; possibly related to emissivity changes)